Cost-benefit model of clonal plants spread patterns

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Abstract: Many clonal plants spread by runners, the conducting organs serving as functional connections with their asexual offsprings, often used to support the offspring by resources. These clonal plants have to deal with few optimization problems during the daughter shoot establishment process. One of the key decisions is about the optimal distance where the daughter shoot should be placed to. If a daughter shoot is placed too close to its mother shoot, it suffers from competition with mother shoot, if it is too far, the costs for establishing and maintaining the connection are high.

We constructed a simple cost-benefit model weighting the rhizosphere overlap against the cost of connection organ to predict the optimal distance between mother and daughter shoot. As a parameters for this model we use a shape of rhizosphere, a unit cost of connection organ and a productivity of environment. The model predicts that plants from more productive environment spread further, but that relationship is modified by unit cost of the spreading organ. It also predicts a range of poor habitats in which clonal plants with long-term connections between mother and daughter shoot cannot exist.

We compared predictions of the model with the data on large set of species featuring type of clonal growth and environmental optima of these species. The data show that there is an overall trend of increasing lateral spread with environmental productivity, but the intensity varies among plants that use different types of clonal organs. It seems that growth patterns of stoloniferous plants, whose are likely to have constant unit cost per stolon length and thus well fit the model assumptions, are in the best accordance with the model predictions.